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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: PACE MICRO TECHNOLOGY PLC)
)
Application No.: 09/809,540)
)
Filing Date: 03/15/01)
)
For: IMPROVEMENTS TO CONTROL SYSTEM FOR NETWORK SERVERS)
)
)
Art Unit: UNKNOWN)

TRANSMITTAL OF PRIORITY DOCUMENT

Director for Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

Enclosed herewith is a certified copy of British Patent Application No. 0006096.2 for which the above-identified patent application claims priority from.

If, for any reason, this priority document is not acceptable, please inform the undersigned as soon as possible.

Respectfully Submitted

HEAD, JOHNSON & KACHIGIAN

Date: 04/02/01

Customer No. 24,118

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Date of Deposit: April 2, 2001
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Signed M Cooke

Dated 15 March 2001

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference — GW-G29486

2. Patent application number *(The Patent Office will fill in this part)* — 0006096.2 — 15 MAR 2000

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Pace Micro Technology Plc

Victoria Road
Saltaire
Shipley
BD18 3LF

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — **U.K** 1588569021

4. Title of the invention — **Improvements to Control System for Network Servers**

5. Name of your agent *(if you have one)* — **Bailey Walsh & Co.**

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

5, York Place
Leeds
LS1 2SD

Patents ADP number *(if you know it)* — **224001**

6. If you are declaring priority from one or more earlier patent applications, give the and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / years)*

7. If this application is divided or otherwise derived from an earlier UK application, the earlier application

Number of earlier application	Date of filing *(day / month / years)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if:*

a) any applicant named in part 3 is not an inventor, or

b) there is an inventor who is not named as an applicant, or

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Continuation sheets of this form	
Description	6
Claim(s)	
Abstract	
Drawing(s)	1 + 1

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Priority Documents	
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11. I/We request the grant of a patent on the basis of this application

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12. Name and daytime telephone number of person to contact in the United Kingdom

G Wood
0113 2433824

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Improvements to Control System for Network Servers

The invention to which this application relates is to improvements in the operation of a server known as a multicast Trivial File Transfer Protocol (TFTP) server which is provided in connection with a network of client apparatus. The server is provided to transmit and transfer data to the client apparatus.

The use of TFTP servers is relatively well known and one area in which the same is used is to provide information to a communications network which includes a number of client apparatus in the form of broadcast data receivers. This form of apparatus is provided in premises in increasing numbers and includes a means for receiving digital data which has been transmitted from a remote location such as by a television broadcaster and carried via any of cable, satellite or terrestrial transmission systems. When received the broadcast data receivers, decode the data and process the same to allow the generation of video, audio and/or text data for display, typically via a television set. The broadcast data receiving apparatus can be connected to the television set or may be provided as an integral part of the same. Each of the broadcast data receiver is provided with further communication means which allow the transfer of data to and from the same, and are provided as part of a networking communication with the TFTP server which can provide updated images or information data at intervals to all of the receivers on the network.

There are however known problems with this type of system as follows. One problem is that when multiple receivers, hereinafter referred to as clients, are required to receive the data from TFTP server, one of the clients is identified as master client by the server. The rate of data transfer is then controlled by the speed at which the master client requests the data and the other clients in the

network will receive the data at the same speed as the master client. This means that if the master client is slow in requesting the data, for whatever reason, then the other clients will also be adversely affected by the decreased transfer rate.

A further problem is that if a client apparatus which is part of the network is rendered inactive and then restarted such as, for example, if the client is rebooted, interrupted or crashes, during the transfer of data from the TFTP server and it is not the master client, there is a possibility that there will be a period of time during which the server will attempt to inform the said client that it is now the master client. Although the server may have a predesignated time out period after which it will cease to attempt to make the client the master client, there is inevitably a delay during which none of the clients involved in the transfer of data can progress.

The aims of the present invention are to provide improvements to the TFTP network and the operation of the same which allow for the more efficient and faster transfer of data where possible and also attempt to avoid unnecessary delays in the transfer of data.

In a first aspect of the invention there is provided a data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred, one of the clients is designated the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients and wherein the rate of transfer of data to each client when elected the master client, is monitored and compared with predetermined transfer rates and if from the comparison it is identified that the transfer rate is longer than that which is required, the TFTP server elects another client which is available as master client.

By electing the client as master client which has shown the fastest rate of transfer so the server can ensure that the data which flows to all of the clients in the network will do so at the fastest possible rate.

In one embodiment the predetermined transfer rate is preset as an optimal time for the transfer of a certain amount of data and the master client is monitored for a set period of time.

In an alternative embodiment the transfer rate for each of the clients, when elected as master client, is recorded over a period of time and a database constructed of the transfer rates for each client and from which database the server will attempt on each occasion to elect as master client that client which shows the fastest transfer rate and in ascending order until an available client is found. Typically this database can be updated on each occasion when a client is selected as master client.

In a further aspect of the invention there is provided a data transfer network comprising a TFTP server connected to transfer data to a series of client apparatus connected to the network and when data is to be transferred one of the clients is designated as the master client and the speed of requests for data from said master client determines the rate of transfer of the data to all of the clients and wherein if one or more of the clients is disabled and cannot act as a master client to receive data this is identified by the TFTP server by monitoring network management messages which identify the disablement or unavailability of the client and whereupon the TFTP server does not attempt to elect the said client as master client.

In one embodiment the network includes ICMP servers and monitors the operation of the same to identify those clients which are unavailable or disabled and, until it identifies that the said client

is live once more, will not attempt to elect that client as the master client.

Thus, by monitoring the low level network management messages on the network so the attempt to elect disabled clients as master clients can be avoided and the hence the same is prevented from causing a delay during which the data transfer is prevented from making progress.

Specific embodiments of the invention will now be described with reference to the accompanying diagram which illustrates in schematic fashion the type of network to which this invention relates.

In the first embodiment, since the TFTP protocol (RFC1350, RFC2090) is a lock step protocol, the data being transmitted by the server is transmitted only as fast as the elected master client requests each block. The master client needs to process incoming data blocks and send its request for the next block as fast as possible in order to sustain a high data transfer rate. If the master client is slow, or the network is losing packets and the server is required to retransmit data blocks, then all of the other clients suffer from the slowing down of the transfer too. If the server monitors the data transfer rate over a reasonable sample period such as 5 seconds and determines, either through configuration or knowledge of the network topology, that the rate is sub-optimal, it deposes the master client and elects a new client as master client.

If the newly elected client is able to receive and respond to the data packets faster then the data is transmitted more quickly than previously and all of the other clients receive the data at that speed, even the prior master client.

It may be the case that the slow client is capable of receiving the data at the same speed as the other clients but is not capable of transmitting the acknowledgements quickly enough and this can lead to the same being too slow to be master clients and they can then subsequently receive the data at the required rate when not required to send the acknowledgements as master clients.

A specific example is now provided. A TFTP server s1 is configured to require that the master client sustains a data transfer rate of 50 kilobytes per second. 10 broadcast data receivers r1-r10 download an OS image over the network concurrently using the multicast TFTP server. Client r1 is a slower machine than clients r2-r10. However client r1 is elected as the initial master client and only maintains a data transfer rate of 40 kilobytes per second. After 5 seconds the server determines that client r1 is too slow and elects client r2 in preference. Client r2 manages to sustain a data rate of 60 kilobytes per second. Whilst client r2 is the master client all the other clients continue to receive data at the faster rate, including client r1.

An example of a further improvement of the application is now described. The TFTP server is transmitting a TFTP OACK datagram to a specific client (e.g. to inform it has been selected as master client) and if the TFTP client software is no longer running then the network software on the client will send back an ICMP Port Unreachable message to the server. Usually the network stack on the server does not know to which socket the message should be delivered and so the server software is unaware that the error has occurred. However in accordance with the invention, if the server monitors the ICMP messages and processes the same it will be able to identify that the TFTP client software has failed and that there is no point in continuing to try and elect that client as master. Thus

the server can elect another client without undue delay to the data transfer.

A specific example is now described in which there are provided 10 broadcast data receivers r1-r10 booting from a TFTP server s1 and client r1 is the master client. The TFTP client on client r2 terminates before client r1 has completed transfer. Upon client r1 completing the transfer, the TFTP server tries to elect client r2 as master however the server receives an ICMP port unreachable message for client r2 and immediately moves on to elect client r3. Previously the server would have delayed for a number of seconds waiting to give client r2 a chance to respond thus holding up the transfer for all the other clients.

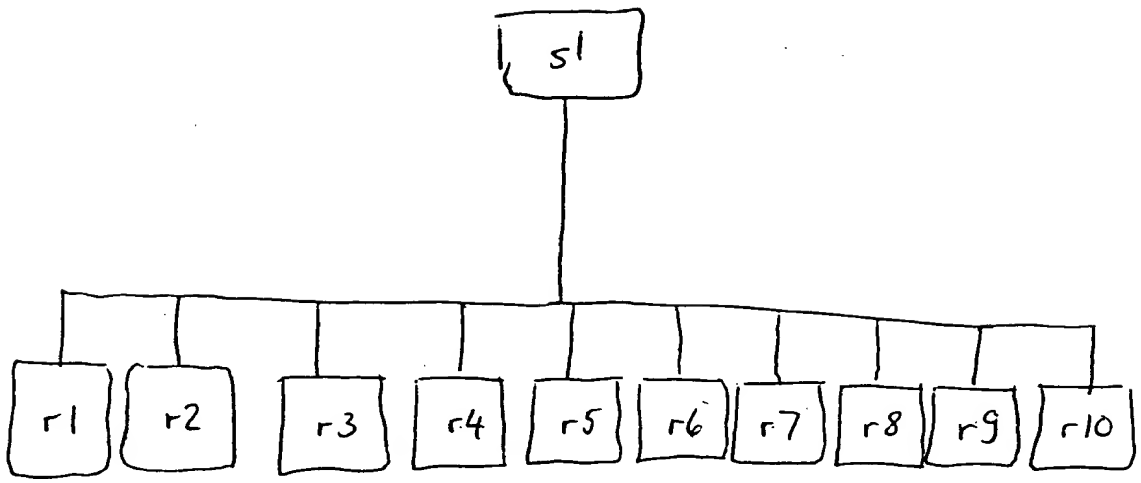

Figure 1